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Memorandum

Date:	23 June 2010
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From:	Chris Zell and Brandon Steets, Geosyntec Consultants
Subject:	Assimilative Capacity Evaluation for Polychlorinated Biphenyls (PCBs) at the U.S. Department of Energy Kansas City Plant (MO-0004863)

1. Background

The National Nuclear Security Administration (NNSA) Kansas City Plant (KCP) is operated and managed by Honeywell Federal Manufacturing & Technologies (Honeywell FM&T). Historic operation and manufacturing processes at the KCP utilized heat transfer fluids containing polychlorinated biphenyls (PCBs). Despite ongoing corrective action measures, storm-water containing low concentrations of PCBs is periodically discharged from KCP outfalls. Honeywell FM&T is actively coordinating with U.S Environmental Protection Agency Region 7 (EPA) and Missouri Department of Natural Resources (MDNR) personnel to quantify allowable storm-water loads to support renewal of the KCP operating permit. Geosyntec has been retained by Honeywell FM&T to provide technical permitting and wasteload allocation assistance during the permit renewal process. At the request of Honeywell FM&T, Geosyntec evaluated data collected within reaches of Indian Creek and Blue River upstream of the KCP to assess existing PCB assimilative capacity. This memorandum documents our evaluation of PCB assimilative capacity within KCP receiving waters.

2. Purpose of Evaluation

Loading capacity (also termed assimilative capacity) is defined by EPA (EPA 2010) as the greatest amount of loading that a waterbody can receive without violating applicable water quality standards (WQS). Most WQS are concentration-based; therefore relative flow contributions dictate differences between applicable water quality criteria and existing ambient concentrations. For discharge scenarios where existing concentrations are near, or exceed

criteria, available loading capacity is negligible. This evaluation assesses available loading capacity for total PCBs within reaches of Indian Creek and Blue River near the KCP. A discussion of applicable water quality criteria and thresholds is provided first, followed by a description of recent and available PCB data collected within receiving streams.

3. Relevant Water Quality Thresholds

3.1 Current Ambient Water Quality Criterion

Missouri's Code of State Regulations (CSR) at 10 CSR 20-7.031 (Table A) includes a Human Health Protection Fish-Consumption criterion (HHC) for total PCBs of 0.045 nanograms per Liter (ng/L). According to MDNR (M. Dkhili, personal communication, 05/13/2010), Missouri's HHC for PCBs is based on the 1980 Human Health equation (EPA 1980a,b) that likely employs a carcinogenic potency factor that was modified from the national value between the period of 1989 to 1991 (**FIGURE 1**, see below). The national HHC for total PCBs enforced by EPA is 0.064 ng/L (EPA 2009) based on a oral Reference Dose (RfD) updated in 2002. The EPA has not promulgatd the national value as states have the option to adopt or maintain criteria more stringent in magnitude, frequency, or duration.

$$1980\ AWQC\ in\ \left(\frac{mg}{L}\right) = \frac{(RL) * (BW)}{ql * (DI + (FI * (BCF))}$$

$$Missouri\ AWQC, 0.045\ ng/L = \left(\frac{(1E-06) * (70)}{7.5956 * (2 + (0.0065 * (31{,}200))}\right) * 1E06$$

Where:
AWQC = Ambient Water Quality Criteria, in mg/L (multiply by 1E06 to yield ng/L)
RL = Risk Level (10^{-5} to 10^{-7}, Missouri default = 10^{-6})
BW = Body Weight, in kg (Missouri default = 70 kg)
ql = Carcinogenic Potency Factor (1980 default = 4.3396, Missouri est. value = 7.5956)
DI = Drinking Water Intake Rate, in Liters (Missouri default = 2 L /day)
FI = Daily Fish Intake, in kg (Missouri default = 0.0065)
BCF = Bioconcentration Factor, in Liters / kg

FIGURE 1. Missouri's Ambient Water Quality Criterion for Total Polychlorinated Biphenyls

3.2 Missouri Fish Tissue Threshold

The Listing Methodology Document (LMD) authored by MDNR sets forth water quality thresholds used in determining beneficial use attainment status for Missouri waterways (MDNR 2010). In addition to the water column concentration value of 0.045 ng/L, the LMD also specifies that waterways where fish tissue levels exceed 0.75 mg PCB/kg tissue may be considered impaired, should specified binomial confidence be achieved. Derivation of the 0.75 mg/kg threshold is documented within a memorandum authored by the Missouri Department of Health and Senior Services (MDHSS 2006). In summary, fish containing greater than 0.75 mg PCB/kg tissue precludes consumption of one meal per month based on a RfD of 0.05 ug/kg/day developed by the Great Lakes Sport Fish Advisory Task Force (Anderson et al. 1993).

Fish tissue concentrations can be related to long-term, steady-state water column concentrations using a Bioconcentration Factor (BCF, see **EQUATION 1** below, and 40 CFR 132.2). Missouri's fish tissue advisory level of 0.75 mg PCB/kg can be related to a water column concentration of 24 ng/L using a default BCF of 31,200 L/kg. It should be noted that the AWQC is significantly lower (three orders of magnitude) than the concentration back-calculated from the fish tissue advisory level. This discrepancy reflects a difference in risk assessment assumptions and approach. The AWQC exposure assumption is that *fish will be consumed* at a rate of 6.5 grams/day (or 198 grams/month) whereas the fish tissue advisory level seeks to limit exposure by reducing consumption.

EQUATION 1:

$$BCF = \frac{Ct}{Cw}$$

Where:
BCF = 31,200 L/kg (EPA 1980)
Ct = tissue concentration in mg/kg (ppm)
Cw = water column concentration in mg/L (ppm)

For the purposes of quantifying loading capacity within receiving waters, water quality data is compared to the existing Missouri AWQC of 0.045 ng/L total PCBs.

4. Available Water Quality Data

Two datasets provided by Honeywell FM&T were reviewed in evaluating available loading capacity. These data include high resolution water column data analyzed using EPA method 1668 (EPA 1999) and fish tissue data collected by Oak Ridge National Laboratory (Peterson et al. 2008) personnel. Each dataset and associated conclusions are discussed in separate sub-sections.

4.1 Water Column Concentration Data

A spreadsheet titled '1668 pcbs.xls' was provided in a MS Excel format and includes high resolution (Method Detection Level 'MDL' = 0.22 ng/L) water column PCB data collected from 10 sites (n=8 per site) from August 2004 to October 2009. Among sites sampled are two locations that represent upstream reaches of Indian Creek (Site ID: SWICU) and Blue River (Site ID: SWBRU) not influenced by KCP discharges **TABLE 1**. It is unknown the extent to which sites SWICU and SWBRU may be influenced by diffuse urban loading from atmospheric, run-off, or baseflow sources.

Table 1. Water Column Concentration Data for Reaches Upstream of Kansas City Plant Discharges. Data provided by Honeywell FM&T**.**

Date	Total PCBs @ Site ID: SWICU (Indian Creek Upstream)	Total PCBs @ Site ID: SW BRU (Blue River Upstream)
8/6/2004	<0.22 ng/L	9.803 ng/L
5/26/2006	<0.22 ng/L	0.540 ng/L
3/7/2007	<0.22 ng/L	< 0.22 ng/L
8/2/2007	<0.22 ng/L	0.685 ng/L
6/25/2008	*0.09	*0.600 ng/L
10/29/2009	*<0.22 ng/L	*< 0.22 ng/L
5/12/2009	<0.22 ng/L	< 0.22 ng/L
10/28/2009	<0.22 ng/L	< 0.22 ng/L
	Site Geometric Mean: <0.22 ng/L Uncertainty(δ): 0 – 0.22 ng/L	Site Geometric Mean: **2 ng/L Uncertainty(δ): 0 – 9.80 ng/L

*Measurable concentrations within field control blank. Sample likely invalid.

**Kaplan-Meier log-normal estimate for small sample size with ≥50% non-detect values. Estimate of central tendency should include at least 4 detectable values for bootstrapping methods. 95% confidence interval around the mean includes zero.

All valid water column data collected at the upstream Indian Creek site are below the method detection level of 0.22 ng/L. Measurable concentrations detected within upstream segments of Blue River are greater than Indian Creek. However, small sample sizes and possible seasonal or flow-driven trends preclude a meaningful test of difference between sites. It is worth noting that stream flow conditions during sampling dates exceed estimated harmonic mean flows of Indian Creek (~3 cfs) and Blue River (~13 cfs) calculated from long-term USGS Gages 06893300 and 06893500, respectively. Definitive estimates of upstream total PCB concentrations based on 1668 data cannot be determined due to the leverage of non-detect values and small sample size.

Therefore, a conclusive comparison between upstream concentrations and the AWQC, yielding an estimate of assimilative capacity, is tenuous with water column data alone. Complimentary to 1668 water column data are fish tissue samples collected by Peterson et al. (2008) that reduce, but do not elminate, assimilative capacity uncertainty. Fish tissue data are discussed in Section 4.2.

4.2 Fish Tissue Data

Fish tissue data collected by Peterson et al. (2008) in June 2007 was provided to Geosyntec in a MS Excel spreadsheet by Honeywell FM&T. This dataset contains 34 fish tissue samples from reaches of the Blue River (Site ID: BLK31) and Indian Creek (Site ID: ICK3) upstream of the KCP. Three fish species were sampled: Green Sunfish (*Lepomis cyanellus*, n=16), Channel Catfish (*Ictalurus punctatus*, n=16), and Black Bullhead (*Ameiurus mel*as, n=2). As mentioned in Peterson et al. (2008), differences in total PCB tissue levels differ by species (**FIGURE 2**). Differences between species may reflect biomagnification and trophic level response, but may also be due to higher lipid content in catfish samples. It is also worth noting that tissue levels for the same species are not significantly different ($p<0.05$) between upstream monitoring sites (Mann-Whitney: $W_{catfish}=81$, $W_{grsunfish}=64$) suggesting that long-term steady state PCB exposures may be comparable within upstream reaches of Indian Creek and Blue River.

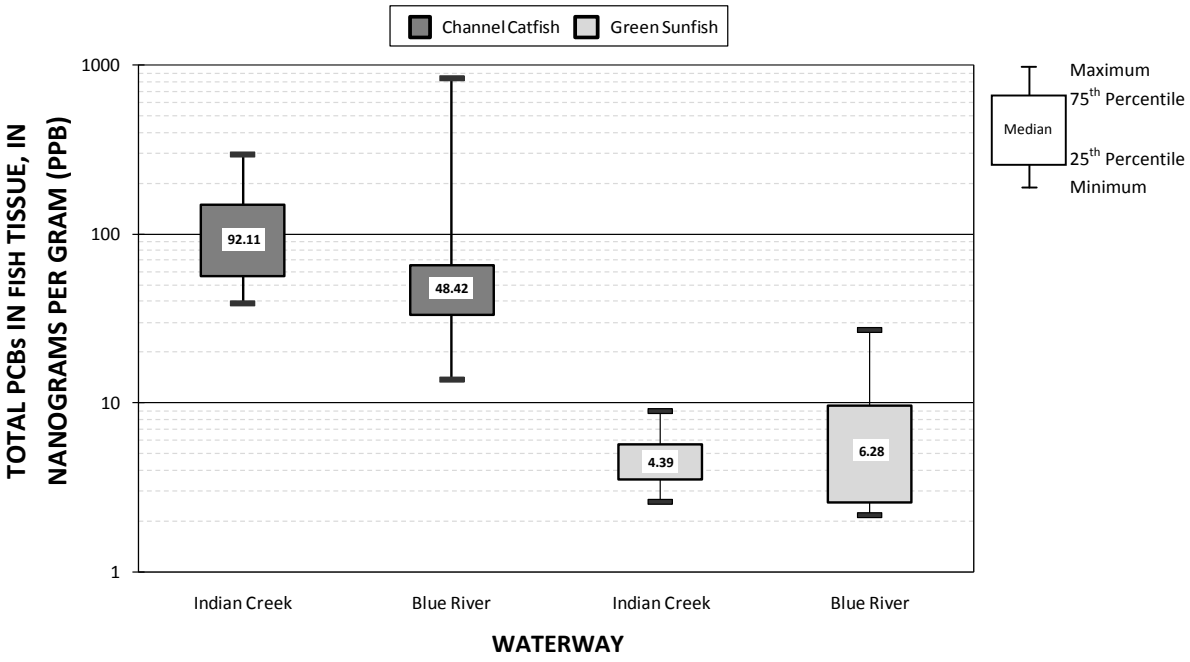

FIGURE 2. Boxplots of Total PCBs in Fish Tissue Samples within Indian Creek (n=16) and Blue River (n=16) segments located upstream of the Kansas City Plant.

As with LMD listing thresholds discussed in Section 3.2, water column concentrations can be estimated from fish tissue data using a BCF. The default BCF used by MDNR for total PCBs is 31,200 L/kg. Recent fish tissue data (June 2007) collected at upstream monitoring locations (BLK31, ICK3) yield back-calculated PCB water column concentrations that exceed Missouri's AWQC of 0.045 ng/L (**FIGURE 3)**.

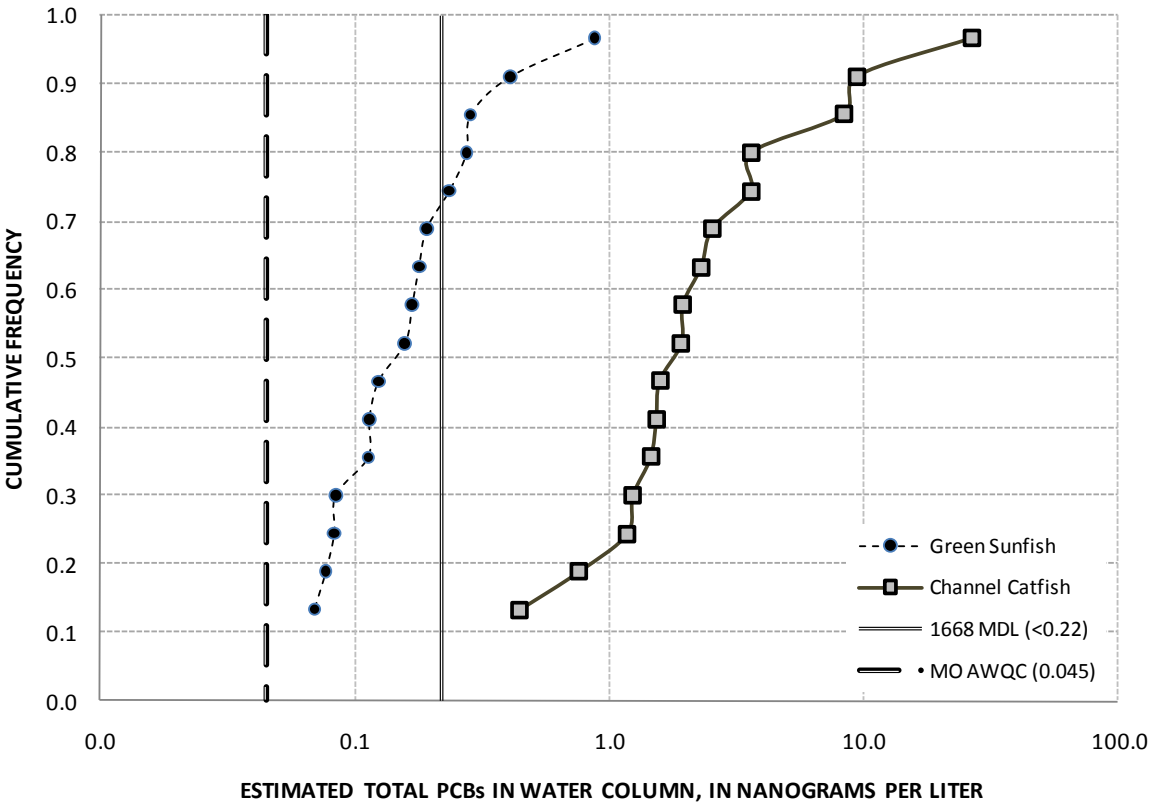

FIGURE 3. Quantile Plots of Water Column PCB Concentrations Estimated From Fish Tissue Data (June 2007, Indian Creek n=16, Blue River n=16) Using a Default Bioconcentration Factor of 31,200 L/kg at Locations Upstream of the Kansas City Plant.

5. Available Assimilative Capacity

Available assimilative capacity, or the time-variable difference between the AWQC and upstream PCB concentrations, is difficult to quantify for areas near the KCP. While substantive uncertainty remains, the weight of evidence set forth in this memorandum supports the hypothesis that upstream PCB concentrations within Indian Creek likely exceeds, and Blue River almost certainly exceeds, the AWQC.

It is reasonably contended that the sample size of direct water column measurements (Section 4.1) is insufficient to assess temporal and streamflow influences. However, the use of fish tissue data to estimate water column concentrations theoretically integrates long-term exposure regimes that include effects of runoff-event loading and sediment resuspension processes. Water column concentrations estimated from upstream fish tissue data are greater than the AWQC when a default BCF of 31,200 L/kg is applied (**FIGURE 4**). Bioaccumulative transfer functions, such as the BCF, are influenced by several site-specific factors, including trophic level, lipid content, and bioavailability. Although a site-specific BCF has not been developed for Indian Creek or Blue River, the BCF necessary for approximately 50% (median 'attainment BCF') of the upstream fish tissue samples to meet the AWQC of 0.045 ng/L is 416,000 L/kg (interquartile range: 114,000 to 1.33E06). A BCF for PCBs an order of magnitude (or more) greater than the 1980 default value could not be found during a review of peer-reviewed literature and agency guidance. A downstream average BCF of 91,000 L/kg was estimated for the KCP area from non-contemporaneous fish tissue and water column concentration data. A fish tissue concentration of 1.4 ug/kg corresponds to the Missouri AWQC (0.045 ng/L) using the default national BCF.

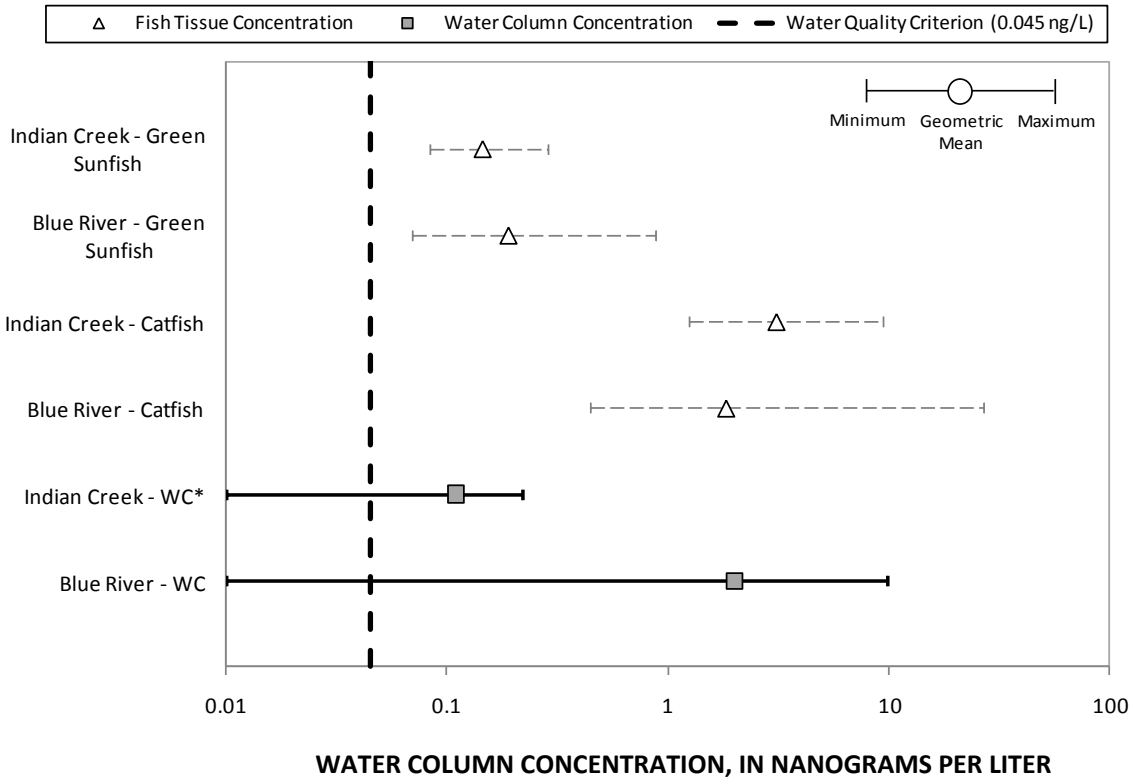

FIGURE 4. Uncertainty (δ) of Available Total PCB Data Relative to Missouri's Ambient Water Quality Criterion. Asterisk Indicates Geometric Mean = Method Detection Level /2. Concentrations Derived From Fish Tissue Samples Using a Default BCF of 31,200 kg/L.

Movement and behavior patterns of sampled fishes potentially confound assimilative capacity conclusions based on tissue data. Fishes collected within reaches located upstream of the KCP may, or may not, have been episodically exposed to higher PCB conditions occuring in downstream reaches. Upstream sampling sites are located approximately 0.75 – 1.4 miles above the KCP. It is unknown how frequently, or if, sampled green sunfish and channel catfish inhabited downstream reaches prior to collection. Natural barriers (e.g. shallow riffles, beaver dams etc.) may preclude reach-to-reach movements during low and moderate flow regimes.

6. Recommendations

The weight of available evidence and information provided by Honeywell FM&T supports the hypothesis that assimilative capacity for total PCBs is negligible in reaches of Indian Creek and Blue River near the KCP. Additional high resolution (method 1668) water column data may be needed to confirm and quantify assimilative capacity if the wasteload allocation process is further pursued.

The viability of the water column wasteload allocation approach is influenced by several considerations, including but not limited to:

- Potential discontinuity between acceptable risk and wasteload allocation assimilative capacity

  Available data suggest that assimilative capacity for total PCBs may be negligible. However, human health risk assessment studies (URS 2001, provided by Honeywell FM&T) at the 95th Terrace Site, which includes KCP Outfall 002, concluded that central tendency and Reasonable Maximum Exposure (RME) cases were within or below acceptable excess cancer risk for five receptors: Utility Worker, Excavation Worker, Construction Worker, Adult Recreational User, and Child Recreational User. Further discussion may be warranted to clarify the need of a wasteload allocation analysis or numeric permit limit if risk to human health receptors near the KCP does not exceed EPA targets.

- Sediment exposure considerations

  Focus on water column assimilative capacity alone may not fully capture all substantive exposure pathways.

- Consensus statistical treatment of non-detect values

  Inherent in any future evaluation of PCB assimilative capacity near the KCP is consensus statistical treatment of non-detect (ND) values. If a wasteload allocation approach is further pursued and additional data collected, it is likely that several ND values will be obtained. How ND values are dealt with (Kaplan-Meier, ROS etc.) should be discussed and evaluated before wasteload allocation-driven sampling begins.

- Trends in fish tissue data

  According to Peterson et al. (2008) total PCBs in fish tissue appear to be generally decreasing with time in the Blue River and Indian Creek. The averaging period for Human Health AWQC is approximately 70 years (EPA 1991). While available data supports a negligible *present-day assimilative capacity*, there may be a point in the future where capacity develops. Continuous simulation could incorporate this phenomena if consensus can be reached regarding the timing and magnitude of assimilative capacity development.

At present, available data support a negligible PCB assimilative capacity in Indian Creek and Blue River upstream of the KCP, as compared to Missouri's AWQC of 0.045 ng/L. It is not clear that PCB concentrations estimated above the AWQC present a substantive risk to human health receptors at the 95th Terrace location (URS 2001). Should numeric permit limits be further promoted by EPA, an AWQC that incorporates site-specific risk factors may be useful in accurately addressing beneficial use protection needs of Indian Creek and Blue River.

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